

and on the western portion they are based on Pamir 5 h and Taghdumbash h of the Pamir triangulation. The longitudes were extended as far as possible by triangulation, and when this was no longer feasible chronometric values were employed; they are referable to the Greenwich meridian, taking that of Madras Observatory $80^{\circ} 17' 21''$ E., and they require a correction of $-2' 34''$ to make them accord with the most recent value of that observatory, viz. $80^{\circ} 14' 47''$ E. The latitudes employed throughout were astronomically determined.

The heights in the eastern portion of this map are based on the fundamental height of Camp 3 of 1896, which was obtained from a series of observations with a mercurial barometer at various camps, the relative heights of which had been determined by triangulation. The observations were computed differentially from Leh by means of simultaneous observations recorded there. In the western portion they are based on the heights of the Pamir Triangulation. A six-inch transit theodolite was invariably employed.

AN OROGRAPHIC MAP OF AFGHANISTAN AND BALUCHISTAN.*

By Colonel Sir T. H. HOLDICH, K.C.I.E., C.B.

THE orographic map of Afghanistan and Baluchistan which is published in this number of the *Journal* is designed to illustrate, on a sufficiently small scale to be readily appreciable, the main structural characteristics of that part of Asia which lies to the west of the central Tibetan and Pamir plateaus, and the general analogy which exists in the construction of the two areas. To illustrate this structural relationship more fully, I will refer shortly to the views held by those modern geographers who have had the best opportunities of examining the mountain masses to the north of India, on the subject of the Himalayan conformation. These views are well epitomized in the articles on "Asia" and the "Himalaya," contributed by Sir R. Strachey to the 'Encyclopædia Britannica.' Although these articles were written many years ago, the researches of such recent observers as Godwin-Austen, Lydekker, Griesbach, Oldfield, and Tanner have adduced nothing which greatly modifies or affects the opinions therein expressed. Sir R. Strachey points out that "the Himalaya, with its prolongation west of the Indus, constitutes in reality the broad mountainous slope which descends from the southern border of the great Tibetan tableland to the lower levels of Hindustan and the plains of the Caspian; and that a somewhat similar mountain face, descending from the northern edge of the tableland, leads to another great plain on the north, extending far to the eastward, to the northern borders of China. Towards its north-west territory this great system is connected with other mountains—on the south with those of Afghanistan, of which the Hindu Kush is the crest, occupying a breadth of about 250 miles between Peshawar and Kunduz; . . . nor can any of the numerous mountain ranges which constitute this great elevated

* Map, p. 596.



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region be properly regarded as having special, definite, or separate existence apart from the general mass of which they are component parts; and Tibet cannot be rightly described, as it has been, as lying in the interval between two so-called chains of the Himalaya and the Kuen Luen or Kara Koram. It is, in truth, the summit of a great protuberance above the Earth's surface, of which these alleged chains are nothing more than the north and south borders, whilst the other ranges which traverse it are but corrugations of the mass more or less strongly marked and locally developed." Further on he says that it is "the northern border of the tableland" of Tibet, "or the summit of its northern slope, so far as it is known," which "seems to form the real watershed between the rivers which flow to the Indian ocean, and those that lose themselves on the plains of Turkestan and Mongolia. The summit of the Himalayan slope forms a subordinate watershed separating the rivers which fall into the Indian ocean into two classes, those that pass directly through the Himalaya to the plains of India and those that are collected on the summit of the tableland and discharged, also through the Himalaya, but by two concentrated streams at distant points towards the opposite ends of the chain." This "subordinate watershed" he refers to as the "Indian watershed." As regards the forces of nature which led to this structure, after noting the inference that the great line of peaks which constitute the "Indian watershed" is due to a primæval line of elevation on the ancient land, and that the movements which raised the subordinate ranges on either side are of later date ("after the middle Tertiary epoch") and coeval with those which raised the tablelands of Afghanistan and Persia, Sir R. Strachey suggests that "such changes of level as are observable on the Himalaya should be regarded as due rather to secondary actions consequent on the general contraction of the cooling terrestrial sphere than to direct elevating forces for which no known origin can be imagined," the effect of this contraction being to set up great horizontal strains, partly of tension and partly of compression, along lines which are approximately parallel, or, under certain conditions, at right angles "to one another and to the line on which the greatest compression, and consequently tension, takes place," and he considers that "it is hardly possible to doubt that the main direction of the principal rivers were determined by anterior lines of dislocation," "the parallelism of many of the great Tibetan and Himalayan rivers for hundreds of miles together, amid such mountains," seeming to be "wholly inexplicable in any other manner." Presumably the structural effect of this "secondary" process of contraction may also be held to account for those transverse water-sheds which connect the parallel ridges, as well as for the cracks or fissures in them which admit of the passage of main drainage lines almost at right angles to their general strike. But such a feature as the splitting asunder of the main chain of a mountain system by the main

arteries of its drainage (which is common to most of the mountain systems of the world) may be also accounted for by the theory of antecedent drainage, i.e. that rivers have clung persistently to their old channels, whilst the mountains have been upheaved across their path; and it is this theory which seems to be best sustained by the geological examinations of the recently surveyed areas of Afghanistan, Baluchistan, and Persia.

Godwin-Austen is inclined to separate the main structural lines of the Himalaya into distinct groups, and to attribute the position of the main geologic axis of elevation of the entire system to the chain of the Mustagh and Kara Koram merging into the Tibetan plateau, separating this line from the Kuen Luen; and he definitely decides that the main chain, or line of highest peaks, of the Himalaya, is that which includes Nanga Parbat on the extreme north-west, and, passing to the north of Nipal, is dominated by Kanchinjunga on the south-east. This is the recognized "snowy range," the range of highest altitudes (averaging 18,000 feet above sea-level), the same range which Strachey calls the "subordinate" or "Indian" watershed. But whatever may have been the structural principles involved, there can be no doubt about the general analogy of mountain conformation throughout South-West Asia.

A glance at the map now published is enough to prove that the tectonic influences which built up the Central Himalaya in pre-Tertiary times, and subsequently added the tablelands of Afghanistan and Persia, have reproduced on a smaller scale, but with much more clearness, the same system of central highland elevation, flanked by the same parallel flexures and corrugations, traversed obliquely by main lines of drainage, as are the ruling, but not always obvious, features of the Himalayan structure.

The meridional range of Sarikol, to the east of the Pamirs, is a typical mountain system consisting of two parallel ridges, of which the eastern is the dominating chain, admitting the passage of main drainage lines, and the western is the true water-divide. To the west of it we have the configuration of the Tibetan plateau more or less repeated, first in the elevated Pamir region, next in the Badakshan plateau, and finally in the tablelands of Afghan Turkestan, merging into one another and into the northern Persia highlands. The Hindu Kush flanks the Pamirs and the Badukshan plateaus, just as the Himalaya flank Tibet. The great longitudinal trough of the Indus and of the Sanpo, beyond the Himalaya, is repeated by the Oxus from Chakmakin to Ishkashim; by the extraordinary trough of the Hari Rud from Doalatyar to Kuhsán; by the Murghab; and in a minor degree by the Andarab and Bamián streams, and (as we shall probably find out eventually) by the Minján. But all these rivers (except the Hari Rud) break northward after rising under the crest of the southern flank of the plateau, and pass through the containing ridges on the northern side of it to the plains of the Oxus. The Hari Rud alone breaks through the southern flanking

chains, rising in the Hazara highlands, which are but an extension of the central plateau southward from the Hindu Kush and Koh-i-Baba. Here we have, from Tibet to the passage of the Hari Rud through the Paropamisus, an immense extent of mountain chain coincident with the main or central water-divide. Sometimes this chain dominates the mountain masses around it, sometimes it sinks to comparative insignificance. As the Muztagh it is a mighty mass of impassable peaks and precipices, but as the Hindu Kush it is distinctly secondary to its own magnificent offshoot the Shundur range. The Hindu Kush only rises to a position of dominance as it approaches Kabul and culminates in the Koh-i-Baba. Beyond the Koh-i-Baba, westward, the Paropamisus (as the bounding chain, or southern wall, of the Firozkhoi plateau) is little more than the scarp or edge of a highly elevated plain. To the south of the great central water-divide, we have the systematic folding of parallel flexures, apart from the main chain, and connected by transverse watersheds (the counterpart of the minor Himalayan chains), strongly emphasized in the Koh-i-Sufed south of the Hari Rud, and the lower ridges which flank it.

But in order to observe the lines of Himalayan structure in a condition of almost primitive simplicity, free from local irregularities and amplifications, we must turn to the frontiers of India and Persia. Here the retaining mountain walls, or revetment of the central plateau, are often indicated by a broad band of ridge-and-furrow formation, dominated by a massive chain of cretaceous peaks (where we may find masses of limestone piled to a thickness of 3000 or 4000 feet), split by the drainage from the plateau, which passes by a series of magnificent gorges on a course obliquely inclined to the strike of the range, to the flats of the Indus provinces.

The central limestone chain on the Indian frontier overlooks a succession of narrow sharp-edged ridges of Eocene and Siwalik formation, which, in a descending scale of altitude, intervene between it and the plains of India. So narrow and so regular, so closely packed, are these ridges in many parts of the frontier that it is quite beyond the limitations of the engraver's art to represent them properly. They would, on the scale of the map, appear as simple scratches on the paper. The main chain of the Sulimani mountains attains an elevation of 11,000 feet above sea, and averages between 8000 and 9000 feet, the plateau to the west averaging 4000, and the plains of the Indus being less than 1000 feet.

The frontier districts which exhibit this formation in the most marked degree are those which enclose the upper tributaries of the Zibob and Kundar, and the hills of Makrán. In Persia the regularity of the system is more or less disturbed, but it is easily traceable along the entire coast-line, the parallelism of the ranges being specially marked about Bandar Abbas, whilst the phenomenon of transverse watersheds is plainly indicated in certain minor ranges north of Kirmán.

Throughout all this region the independence of main water-partings, or divides, and main flexures, or mountain chains, is strongly marked. Indeed, it not infrequently happens that the longest and most continuous water-divides are to be traced along lines transverse to the main ridges. Examples of "antecedent" drainage are abundant, as are also instances of that process of "cutting back" by which the head of a river gradually works upward, appropriating fresh areas and enlarging its catchment basin. A notable feature in the map is the vast area of hydrography which has no ocean outlet, the drainage losing itself in the vast lagoons and "hamúns" of the Helmand, Mashkel, Lora, Jar Morian, and other minor lakes and swamps.



A JOURNEY THROUGH SOUTH-WEST SECHUEN.

By EDWARD AMUNDSEN.*

IT was snowing lightly as we left Mili Gen-chen on January 10, 1899, the first snow since leaving Chetog. A few farmhouses were seen on the steep hill slopes. Next day we crossed the high pass of Si-li-shan. We halted for tea on the high snow-covered plateau, and met a good number of muleteers *en route* for Ta-chien-lu, as we ascended the gentle slope to the summit, which was reached at noon. From this point we expected to get a view of low-lying level country, but to our dismay nothing but mountain after mountain could be seen in any direction, and to the south a blue haze, which I understood was caused by the heat. A steep descent brought us down to fine grassy pasture ground, sometimes made use of by Lolos, who keep the people hereabout in great dread. At the bottom we crossed a stream by means of a wooden bridge, where I was shown the mouth of a remarkable cave, which is held as sacred by pilgrims, who come from far to make a journey in it. It is said that a journey of twenty days may be made in this spacious cave. During these later years, however, the people are forbidden to enter it, as many who went in never came out again.

We stayed this night in a village of five houses, and the next day halted for breakfast at a village of ten or twelve houses—the last in Mili. An hour's ride further brought us to the border-line between Mili and Yung-lin, which is also the boundary between Se-chuen and Yun-nan. After crossing the border we entered on a long populous plain, which becomes wider as one gets nearer the head village, where there is a Chinese yamen, or rather a poor shed called by that name, with two stone lions in front, to lend some appearance to the place.

* Continued from vol. xv., p. 625. Received after the publication of the first instalment. Map, p. 596.